



General Training On Methodologies For Geological Disposal in North America

IAEA Network of Centers of Excellence



Nuclear Waste Disposal Concepts

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Overview

- Waste program history and technical approach
- Drivers for waste policy and their current relevance
- Technical insights from work to assess performance of a permanent radioactive waste repository
- Regulatory and policy issues associated with nuclear waste disposal



U.S. Radioactive Waste Management History

- 1957 - NAS Committee recommends:
 - geologic disposal, particularly in salt formations
 - development of process to solidify waste liquids
- 1957-72 -- Abandoned salt mine near Lyons, KS investigated. Discovery of old wells and public opposition led to cancellation of this project.



Waste Management History, Continued

- After failure of Lyons, Kansas project, other technologies considered
- Subseabed program initiated in 1973
- Other approaches considered included disposal or storage on a remote uninhabited island, space disposal, transmutation



Waste Management History – U.S. Defense Wastes

- The Waste Isolation Pilot Plant (WIPP) was authorized by Congress in 1980 for disposal of transuranic waste. Site is in bedded salt, ~ 650 m deep, in southeastern New Mexico
 - Construction began in 1981
 - First disposal of waste occurred in 1999.
- 1985 proposal to backfill and cover Hanford waste tanks; not consistent with EPA and NRC requirements for HLW. Later plans are to vitrify tank wastes.



Waste Management History, Continued

- Nuclear Waste Policy Act of 1982 - Spent fuel and HLW to go to a geologic repository. Process to select 3 sites for characterization defined. Process to identify candidates for 2nd repository initiated.
- 1983-85 -- DOE screens down to 9 sites, then 5 sites, then recommends 3 sites for characterization (Yucca Mountain, Hanford, WA, and Deaf Smith, TX). Ranking system put Yucca Mountain and Hanford 4th and 5th on postclosure performance.



Waste Management History, Continued

- Nuclear Waste Policy Act Amendments of 1987 - Yucca Mountain selected by Congress as only site for characterization. Act led to halt of work on a Tennessee Monitored Retrievable Storage facility. Subseabed and 2nd repository programs also halted.
- 1996 - Court rules that 1982 NWPA requires DOE to begin to accept waste in 1998



1982 Waste Act Policy Objectives

- Utility industry wanted early demonstration of feasibility of permanent disposal, to remove this major obstacle to expanded use of nuclear power
- Philosophy – we benefited from the activity that produced the wastes, so we should deal with them. Fee on nuclear generated power to pay for disposal program.
- Although not in the 1982 Act, environmental groups and Carter administration wanted:
 - to assure that U.S. spent fuel would not be reprocessed
 - early disposal of spent fuel to avoid proliferation risk associated with spent fuel plutonium content



Waste Management Objectives -- Then and Now

Assure that spent fuel would not be reprocessed

- Then -- active plans to reprocess U.S. spent fuel. Carter Administration interest in preventing this and in persuading other countries to forgo reprocessing
- Now -- U.S. reprocessing not economically attractive, U.S. example not persuasive to Europeans or Japanese.



Waste Management Objectives -- Then and Now

Need for early disposal

- Then – so nuclear power use could continue
- Now – one of many obstacles to new nuclear plant orders
- Then – to avoid spent fuel proliferation risk
- Now – spent fuel standard for security of fissionable materials

Waste Management Objectives -- Then and Now

Obligation of current generation

- Then – to dispose of wastes so future generations would not have to deal with them and to take away the reprocessing option
- Now – to manage safely while preserving options for future generations

Current Spent Fuel Management Considerations

- At-reactor storage capacity threatens continued operations of some plants
- State/utility concerns that federal government will not provide waste management with waste funds
- Significance to DOE of 1996 ruling requiring DOE to start accepting waste for disposal in 1998 not clear
- Planned capacity of Yucca Mountain insufficient to handle projected inventory

Technical Insights Gained through Efforts to Implement Geological Disposal

- Inability to use scale factors to model km-scale geologic settings based on core samples (recent work on WIPP shows progress on this issue re retardation)
 - matrix versus fracture flow
 - inhomogeneities
- Recognition that a high degree of isolation (versus dilution) will lead to locally high concentrations over very long future times



Technical Insights, Continued

- Sensitivity of assessment processes and results to the time scale of analysis, (i.e., whether the analysis is over 10,000 vs 1,000,000 years)
- Comparative effectiveness of engineered versus geologic barriers depends on the isotope and regulatory period
 - long-lived canisters and carbon-14 (Yucca Mountain)
 - local geochemistry control and Pu solubility (WIPP)



Insights for Siting Repositories

- Value of having site with no potable water (e.g., WIPP, Swedish concept)
- Natural resource issues are better dealt with during siting rather than during characterization and licensing
- Value of unsaturated site for operations, retrievability, versus saturated site for stability of UO_2



Siting Waste Disposal Facilities

The siting process should determine:

- whether presence of natural resources disqualifies site
- human intrusion assumptions to be used for compliance determination
- biosphere assumptions to be used for compliance determination



Siting Waste Disposal Facilities

Is both local and state support required to succeed at waste disposal? What processes/factors can lead to political support for project?

- Local support strong for some facilities, e.g., WIPP
- Local opposition strong at some sites, e.g., NY LLW
- State opposition strong at some sites, e.g., Yucca Mountain



Retrievability/Ability to Modify Facility

Retrievability desirable if:

- understanding of repository performance changes and weaknesses identified
- innovation in waste treatment, packaging, or repository design
- reprocessing becomes desirable

Retrievability undesirable if permanent removal of nuclear materials sought



Retrievability/Ability to Modify Facility

- Highly important -- MRS
- Medium-to-high -- unsaturated site
- Low -- saturated site, perhaps in salt
- Negative -- reprocessing, subseabed



Other Nuclear Wastes

Political optimization \neq technical optimization

- too many LLW compacts
- WIPP requirements regarding waste characterization, acceptance, transport



Unknowable Future Events

- Inadvertent human intrusion
 - how frequently and by what technology?
 - would hazard be detected and intrusion remediated?
 - would markers, barriers and records deter or encourage intrusion?
- Institutional controls -- how long can they be effective?
- Nature of future societies
 - food and water sources
 - water treatment, detection of radionuclides



Institutional Obstacles to Better Use of PA Results

- Inscrutability of analyses, especially when full uncertainty analysis included
- Detailed analyses of unimportant processes (e.g., climate change at WIPP)
- Compliance versus safety emphasis

Compliance ≠ Safety

- Time period of regulatory concern
- Releases versus doses or risks
- Releases to nonpotable water

Comparisons Between Repository and MRS Safety for Spent Fuel and HLW

Can we compare the benefits and risks of storage versus disposal in an evenhanded way? Current comparisons:

- Imply, without analysis, that a repository is safer.
- Time period of comparison is problematic.
- Compares dissimilar benefits/technologies, i.e., disposal versus storage
- Raise a red herring regarding ability to store materials safely

Based on efforts to date:

- Early acquisition of land important to remove late obstacles (e.g., Ward Valley, WIPP)
- Early consideration of transportation needs, regulations, capabilities, and state and local government concerns important
- Repository concept that avoids need to characterize far-field geology desirable

Recent Events

- Legal Challenges to Yucca Mountain lead US Court of Appeals to reject 10,000 year period of applicability of the EPA standards.
- The US Government has decided not to appeal this decision. An industry group appeal to the Appeals Court was rejected; this group has now appealed to the US Supreme Court.
- Absent acceptance of the appeal, EPA will need to revise the standard through a new rulemaking.

Final Comments

- Cost versus benefit of HLW program to date seen by many as poor
- Technical aspects of safe disposal not considered important by many in nuclear community; public perceives that industry approach emphasizes PR
- No technical obstacles to safe management for a period of ~100 years
